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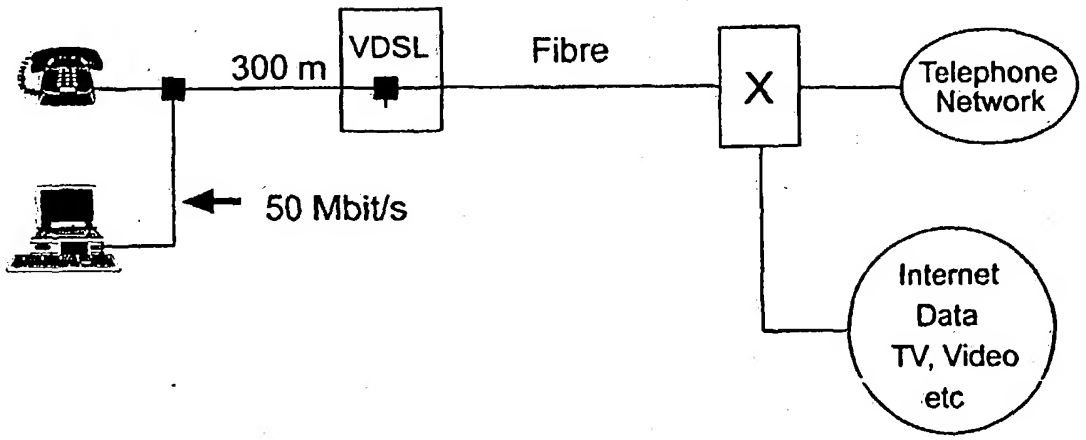
(54) Title: VDSL MODEM DIVIDED INTO A DIGITAL AND AN ANALOG PART



(57) Abstract

The invention relates to a new type of VDSL-modems where the VDSL-modem is divided into on one hand an analog part which is placed in the optical node, and on the other a digital part which is placed in the local station. The analog part of the VDSL-modem consists of A/D-converter and D/A-converter, filter, amplifier, hybrid/balun, adaptive noise attenuator, optical interface and possibly echo canceller. The digital part of the modem consists of an FFT/IFFT-processor, a synchronizer, an equalizer, an interleaving unit, an error correction unit, a protocol manager, and an optical interface. The invention simplifies i.a. synchronization of the modems and reduces the power consumption in the optical node. The multiplexor function in the optical node in addition will be simpler because it need not manage a protocol.

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VDSL MODEM DIVIDED INTO A DIGITAL AND AN ANALOG PART

Field of the invention

The present invention relates to a VDSL-modem.

Prior art

One of possible technologies for FTTN (Fibre to the Neighbourhood) is VDSL (Very High Data Rate Digital Subscriber Line). In simple terms VDSL transfers high data rates over short distances in copper cable in the Public Switched Telephone Network with a rate which depends on the current length of the copper cable. The maximum downlink rate varies between 51 and 55 Mbit/s over copper cable with a lenght of up to 300 m. The downlink rate is about 13 Mbit/s over a copper cable with a length of about 1500 m. The uplink rate in the previous VDSL-models was asymmetric just as ADSL, but with a rate of about 1,6 - 2,3 Mbit/s. Both data channels are separated in frequency from the channel bands which are used in POTS and ISDN, which makes possible for service suppliers to superimpose VDSL on existing services. At present also the two high speed channels for uplink respective downlink are separated in frequency. When the need increases for higher rates in the uplink channel, or symmetric rates, the VDSL-systems need to use echo cancelling. In order to correct errors which occur due to noise, VDSL utilizes for instance Forward Error Correction (FEC) with sufficient interleaving for correction of all errors.

At use of VDSL-modems for providing broadband services the lenght of the last copper line up to the subscriber is a limiting factor. This distance must be made as short as possible. Figure 1 shows how a VDSL-modem according to the prior art is arranged in a node between a subscriber and a local station (exchange; X). The distance from the node with the VDSL-modem to the subscriber is about 300 m, at which the transmission rate may be about 50 Mbit/s in the

downlink. The transmission between the node and the exchange (X) is made by means of fibre. As has been mentioned above, it is important to keep the distance between the node and the subscriber as short as possible. One way of effecting this is to extend the network with special optical nodes (ONU), as can be seen in Figure 1, between the local station (exchange) and the subscriber. The optical fibre network consequently shall reach all these nodes, and the location is selected with intention to minimize the lenghts of the copper line. According to Figure 1 one so far has placed the whole VDSL-modem in these nodes and made these communicate with local station (the exchange).

One problem by arranging the whole VDSL-modem in the optical node is that one will have problems with the synchronization of different VDSL-modems. The synchronization between these modems is of greatest importance, for instance for the duplex method which is utilized in Telia´s patent application 9502775-1, which by this is included by reference.

Another problem is that the multiplexor function in the optical node is complicated and must be able to handle different protocols such as ATM, IP etc.

The aim with the present invention consequently is to solve these problems and reduce the complexity in the optical nodes.

Summary of the invention

This aim is reached by a VDSL-modem, at which the VDSL-modem is divided into on one hand an analog part which is located in the optical node, and on the other a digital part which is located in the local station (the exchange).

Besides this solving above mentioned problem, the power consumption in the optical node will be considerably lower.

Further characteristics are given in the subclaims.

Brief description of the drawing

Figure 1 shows schematically a VDSL-modem according to the prior art.

Embodiment of the invention

As an element in reducing the complexity in the optical nodes is in this invention suggested that the VDSL-modems be divided into analog and digital parts. The analog parts are placed in the optical nodes, whereas the digital parts are placed in the local station. The communication between these parts is made via the optical fibre in form of digitized samples of the analog signal which are transmitted on the copper line.

The analog part of the VDSL-modem consists of A/D- and D/A-converter, filter, amplifier, hybride/balun, adaptive noise attenuator, optical interface, and possibly echo canceller.

The digital part of the modem consists of FFT/IFFT-processors, synchronizers, equalizers, interleaving and error correction, protocol managers and optical interface.

Since all advanced technology such as protocol manager etc is in the digital part at the station, the complexity is reduced in the optical node. By providing optical fibre interfaces is consequently made possible that the analog and digital parts of a VDSL-modem can be placed in different places, for instance in the node and at the station.

The invention is only restricted by what is indicated in the following patent claims.

PATENT CLAIMS

1. VDSL-modem, c h a r a c t e r i z e d in that said modem is divided into on one hand analog parts and on the other digital parts, at which said analog and digital parts are separated from each other and placed at different places.

2. VDSL-modem according to patent claim 1, c h a r a c t e r i z e d in that said analog parts are placed in a node between just any number of subscribers and at least one station, and that said digital parts are placed in said at least one station.

3. VDSL-modem according to patent claim 2, c h a r a c t e r i z e d in that the communication between said analog parts and said digital parts is made via optical fibre.

4. VDSL-modem according to patent claim 3, c h a r a c t e r i z e d in that analog signals on copper line from just any subscriber are converted to digital signals by an A/D-converter arranged in said analog parts, at which said analog parts in said node transfer said digital signals to said digital parts in said station.

5. VDSL-modem according to any of the previous patent claims, c h a r a c t e r i z e d in that a protocol manager is arranged in said digital parts.

6. VDSL-modem according to any of the previous patent claims, c h a r a c t e r i z e d in that said analog parts of said modem include A/D-converter, D/A-converter, filter, amplifier, hybrid/balun, adaptive noise attenuator, optical interface.

7. VDSL-modem according to patent claim 6, c h a r a c t e r i z e d in that said analog parts of said modem include echo canceller.

8. VDSL-modem according to any of the previous patent claims, c h a r a c t e r i z e d in that said digital parts of the modem include an FFT/IFFT-processor,

synchronizer, equalizer, interleaving device, error correction unit, protocol manager and an optical interface.

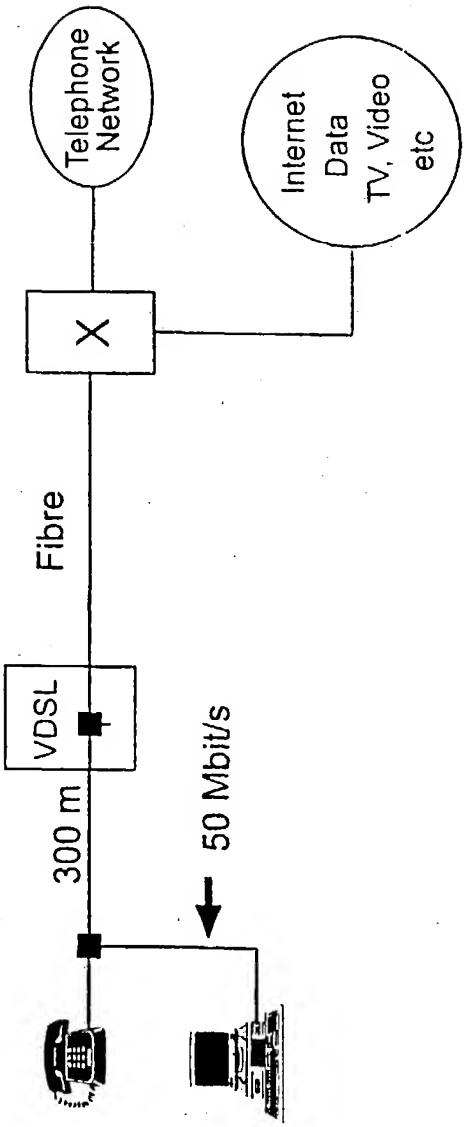
Telephone Network
Internet Data TV, Video etc
X
Fibre
VDSL
300 m
50 Mbit/s

Figure 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01114

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04M 11/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 5655010 A (THOMAS J. BINGEL), 5 August 1997 (05.08.97), column 3, line 52 - column 5, line 18, claim 1, abstract	1
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A	US 4310721 A (HAROLD J. MANLEY ET AL), 12 January 1982 (12.01.82), abstract	1-8
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X	US 5369687 A (STEVEN E. FARKAS), 29 November 1994 (29.11.94), column 3, line 24 - column 5, line 17, figures 1a,1b, abstract	1
Y		5-8
A		2-4
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 October 1998	20 OCT 1998
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5008901 A (CLIFFORD H. WALLACH ET AL), 16 April 1991 (16.04.91), column 1, line 7 - column 3, line 68, figures 1,2, abstract ---	5,6,8
Y	US 4799214 A (TAKASHI KAKU), 17 January 1989 (17.01.89), figure 4, abstract --- --------	7

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
PCT/SE 98/01114

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5655010 A	05/08/97	NONE	
US 4310721 A	12/01/82	CA 1139884 A	18/01/83
US 5369687 A	29/11/94	CA 2111038 A	18/06/94
		EP 0602894 A	22/06/94
		JP 7046337 A	14/02/95
US 5008901 A	16/04/91	NONE	
US 4799214 A	17/01/89	DE 3684129 A	09/04/92
		EP 0229524 A,B	22/07/87
		JP 1893326 C	26/12/94
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		JP 62147820 A	01/07/87